UDC: 004.89 DOI: https://doi.org/10.15407/jai2021.01.095

PRACTICAL EXPERIENCE IN THE TECHNICAL SYSTEMS CREATING WITH THE ARTIFICIAL INTELLIGENCE ELEMENTS

V. Pisarenko[1], J. Pisarenko[1], O. Gulchak[1], T. Chobotok[1], A. Boyko[1]
[1,2,3,4,5]V.M.Glushkov Institute of Cybernetics of the NAS of Ukraine, Ukraine
Academician Glushkov Avenue, 40, Kyiv, 03680

[1]http://orcid.org/0000-0001-7798-7673
[2]http://orcid.org/0000-0001-8357-8614
[3]http://orcid.org/0000-0002-7757-7153/
[4]http://orcid.org/0000-0002-5444-7110
[5]http://orcid.org/0000-0003-0765-4050

Abstract. The practical experience of solving scientific tasks using artificial intelligence technologies is presented. The authors offered their understanding of the term "artificial intelligence". Describes the development of the dept. №265 of Mathematical Problems of Applied Informatics V.M. Glushkov Institute of Cybernetics of the NAS of Ukraine in the creation of technical systems with elements of AI mainly to work in extreme environments. The purpose of the authors is to provide useful information to develop a strategy for the development of AI in the Ukraine. Some of these studies: monitoring the territory and management of land use technologies using remote sensing technologies from aircraft, spacecraft, unmanned aerial vehicles; monitoring the technical equipment of the underwater environment (technical means of searching for a sunken object of the submarine type for emergency operations are being developed); mine safety control (risk research during mining, creating robotic systems with elements of artificial intelligence for studying the conditions of work in the mine, warning accidents and emergency rescue work). The next direction is the diagnosis and treatment of addictive patients using the principles of therapeutic methods BiofeedBack. Attention is paid to the development of robotic technical systems with AI for servicing cosmic long missions. For this, theoretical studies have been conducted on the creation of a live brain mathematical model for its use in the development of the "artificial brain" of robots. The authors gave a list of tasks that can solve AI in programs for long-term space flights, technologies and systems that should develop in the first place to implement these tasks.

Keywords: artificial intelligence, artificial brain, robots, BiofeedBack, the underwater environment, long-term space flights.

ПРАКТИЧНИЙ ДОСВІД СТВОРЕННЯ ТЕХНІЧНИХ СИСТЕМ З ЕЛЕМЕНТАМИ ШТУЧНОГО ІНТЕЛЕКТУ

В.Г. Писаренко[1], Ю.В. Писаренко[2], О.Е. Гульчак[3], Т.І. Чоботок[4], А.Г. Бойко[5]
[1,2,3,4,5]Інститут кібернетики імені В.М. Глушкова Національної академії наук України, Україна
Проспект Академіка Глушкова, 40, м. Київ, 03680

[1]http://orcid.org/0000-0001-7798-7673
[2]http://orcid.org/0000-0001-8357-8614
[3]http://orcid.org/0000-0002-7757-7153/
[4]http://orcid.org/0000-0002-5444-7110
[5]http://orcid.org/0000-0003-0765-4050

Анотація. Викладено практичний досвід вирішення наукових завдань з використанням технологій штучного інтелекту. Автори запропонували своє розуміння терміну «штучний інтелект». Описано розробки відділу математичних проблем прикладної інформатики Інституту кібернетики імені В.М. Глушкова Національної академії наук України в створенні технічних систем з елементами штучного інтелекту в основному для роботи в екстремальних середовищах. Мета авторів - надання корисної інформації для вироблення стратегії розвитку штучного інтелекту в Україні. Деякі з цих досліджень: моніторинг території і управління технологіями землекористування з використанням технологій дистанційного зондування Землі з бортів авіакосмічних носіїв,

безпілотних літальних апаратів; моніторинг техносфери підводного середовища (розробляються технічні засоби пошуку об'єкта, що потонув, подібного до підводного човна, з метою проведення аварійно-рятувальних операцій); контроль шахтної безпеки (дослідження ризиків при видобутку корисних копалин, створення робототехнічних систем з елементами штучного інтелекту для дослідження умов роботи в шахті, попередження аварій і проведення аварійно-рятувальних робіт). Наступний напрямок - діагностика й лікування адиктивних пацієнтів (алкоголізм, наркоманія) з використанням принципів лікувальних методик biofeedback. Приділено увагу питанням розробки робототехнічних систем з AI для обслуговування космічних тривалих місій. Для цього проведені теоретичні дослідження зі створення математичної моделі живого мозку для її використання в розробці штучного мозку роботів. Автори надали перелік завдань, які може вирішувати штучний інтелект в програмах тривалих космічних польотів, технології та системи, які для реалізації цих завдань повинні мати розвиток.

Ключові слова: штучний інтелект, штучний мозок, роботи, біологічний зв'язок, підводне середовище, тривалі космічні місії, feedback.

Introduction

In this article, the authors team would like to suggest to consider the tasks that can already be solved in our country using artificial intelligence technologies. Such focus of developments in the field of AI is prevalent in the work of the Cybernetics Institute of the National Academy of Sciences of Ukraine, and in particular, in the creative developments of the doctor of Physical and Mathematical Sciences, professor, Valery Pisarenko's, team of 265 mathematical problems of applied informatics of this institute.

Formulation of the problem

There are two close interpretations of the "artificial intelligence" concept that used related to the specifics of research in the Department 265.

1.In our interpretation, artificial intelligence is a combination of information technologies, including receipt, interpretation and processing of incoming useful information. At the same time, receiving, treating new knowledge, while maintaining them, argued conclusions are formed for their goals; At the same time, self-study is carried out in this way, which in a certain sense is similar to similar technologies for self-assessment of living beings.

2.The search intelligence is a set of algorithms for solving the actual creative tasks formulated by the Consciousness of a person for the specific tasks of practice.

In this context, it is appropriate further to summarize the work of the department of mathematical problems of applied informatics (department No. 265 of the Cybernetics Institute named after V.M. Glushkov) in the field of technical systems with AI elements creating. We hope that this will be useful for developing a strategy for the development of artificial intelligence in Ukraine. The authors consider the indicated areas of work relevant to Ukraine. Further, the description of such works is enlarged.

The purpose of such developments is the creation of technologies using robotic systems with elements of AIs intended for the above options for functioning them in extreme conditions. The use of intellectual robotics samples for such purposes allows, in particular, to save human health and life resource.

1.Land use monitoring

Monitoring the territory and management of land use technologies using Remote sensing land (RSL) technologies from aircraft carriers. In particular, for topical tasks of the agricultural complex of Ukraine and Belarus, there is a joint agreement providing for monitoring the state of the soil (for example, to support sowing and / or cleaning work "), control of the vegetative state of cultural plants on agricultural sizes, current analysis of the degree of ripeness of agricultural culberry and preparedness for harvesting.

These operations are manufactured using a number of specific means and technologies of AI, which allow you to decipher the spectral data of the RSL and make decisions that take into account the existing experience of growing similar agricultural culctures at specific similar territories. The final decision is made by an experienced expert - a person, he remains the last word.

In this case, the efficiency is not a paramount task.

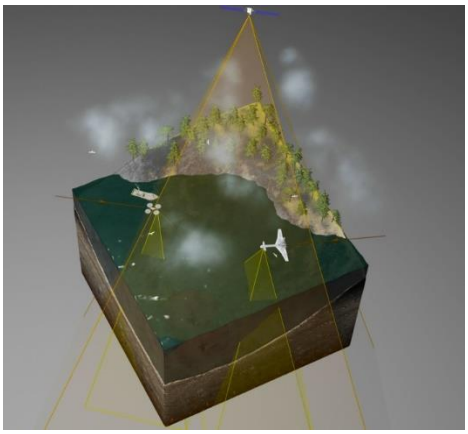

Fig. 1. Illustration of cooperation with NAS of Belarus: understanding monitoring using UAV or cosmic deviation media

2.Monitoring the optimal control of the underwater environment engineer

In the context of the optimal control of the technosphere of the underwater environment, the study of basic risks remains relevant for the purpose of the implementation of specific technologies for optimal underwater technosphere, including emergency rescue operations in this environment. On this subject, the following was actually done: the main components of the methods and technical means of monitoring the movement under water testing a robot scout (TRS) in this medium were developed. An example of such technologies will be the technical means of searching for a sunken object of the emergency submarine type in order to conduct relevant rescue operations.

Fig. 2. Visualization of the typical scene of the testin robot scout (TRS) work in the aquatic environment (view from the underwater camera of acoustic wireless video data transfer)

3.Mine security monitoring

In the interests of mining security - a study of risks in the implementation of mining technologies and determination of the effectiveness of relevant rescue workshop in a mine technosphere. The authors in their scientific works analyzes the use of robotic systems in tasks of high importance for increasing the safety in the Ukrainian coal industry.

In the department №265 of Mathematical Problems of Applied Informatics V. M. Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine made the following:

3.1. The basic attributes of the developed author's technology analysis of the current risks of the explosion of the methane-coal mixture, the mathematical modeling of the data of the current risks was carried out, the instrument support for the timely detection of this dangerous situation was developed. Now creation of technologies for building mobile robots with AI and the functions of optimal control of extreme situations is developed. That is, the timely detection of pre-emergency zones with a high content of methane and high risk of sparking (as a possible source of explosion of methane-coal mixture) avoids a dangerous explosion situation.

Calculate the probability of an explosion possible with the help of a special computational decision module, while the current level of methane concentration in the mine atmosphere and the presence of detected spark sources is taken into account.

3.2. For a reduction in the probability of an explosion in the mine, the use of a pneumatic source for the operation of basic mine aggregates (instead of electric motors) under high risk of explosion from working electrical equipment is recommended.

3.3. Having its sensors with a large number of different potentially explosive parameters of the mine medium (temperature, concentration of coal mixture and methane in the atmosphere of the mine, "alarming sound", the facts of detection of "nontypical" vibration, a specific hiss preceding, usually accidents, etc.) robotics systems with elements of artificial intelligence are able to predict the appearance of a high probability of an accident.

4.About some technologies relevant to ensure mine safety

For example, a mobile "security controller" (MSC) in offline mode moves through the mine space, monitor the situation in the mine, calculates the current changing risks of the accident, transmits relevant information remotely to the control panel for the purpose of making a decision by the management of the enterprise on emergency measures to urgently counter the growing risks of an accident. In the ideal case, the specified robot of the MSC should also be able to make quickly necessary actions to preserve not only "itself" (by urgent evacuation from the zone of the growing risk of collapse, for example), as well as to work as a rescuer at a mine in the factories.

5.Diagnostics and treatment of addictive patients

Actual direction of diagnosis and treatment of dependent patients (alcoholism, drug addict, gambling, etc.) is the development of appropriate techniques. Such diagnostic techniques should be adaptive to the current state, prehistory of the disease, the patient's intelligence level, suggestion and other identity features and should use the principles of therapeutic biofeedback (with biological feedback) methods [6, 7, 8].

Fig. 3. Working time patient preparation for therapeutic procedure of biological feedback methodology

Here, the use of technologies of AI is certainly necessary in the sense that it is about solving a multi-criteria task (with adaptive control).

Fig. 4. Working moments of use of therapeutic biological feedback methodology

6.Scientific research in agro-industrial sphere

A feature of the agro-industrial sphere is the high probability of distribution (remoteness) of production or research sites in areas far from each other for a considerable distance. Moreover, the center for collecting information and processing it, as a rule, is concentrated in one compact place. For research institutions, this feature often acquires a state of rather urgent problem, which requires the search for new innovative approaches.

The authors in their scientific works proposes elements of the concept of construction and technological solutions for methods of operational data transfer of field research from agricultural areas to a remote database for data storage with the possibility of feedback. [9].

As an example, the procedure of qualification examination of plant varieties with the definition of the criteria of "difference, homogeneity and stability" and "suitability for propagation of the variety in Ukraine" was chosen.

7.Space studies: dangerous factors and use of "cybercosmonauts"

This refers to the development of robotic technical systems with AI to maintain the needs of cosmic long-term expeditions. Recently, the projects of distant space missions are not simply relevant and trendy, but evenly developed in detail. If our state can

now consider himself a cosmic power, it is possible to promote individual projects to ensure certain problems of long missions that we are or not by us, but will be conceived and developed.

In [7, 8], mathematical modeling of a lively neural network was carried out, as a result, a model of relevance of a lively neural network was proposed, taking into account the nature of the live brain of the delay of neurons interaction for the functioning of the live brain.

This model can be used to a deeper understanding of the functioning of the CNS of a person, but also in research on the development of artificial brain, similar to the human. This is important for develop concepts and technical solutions to construct relevant robotic systems with elements of artificial intelligence.

Scientific literature on space research, as well as some of our works, including are devoted to the analysis of risks for people and robots in long-term space expeditions. Perhaps the following solution: Robots with artificial intelligence as an alternative to the crew of cosmonauts of the spacecraft (SC) [10, 11].

The solution thus lies in the planning plane for distant interplanetary space expeditions, precisely "unmanned crews". Obviously, modern robotic complexes designed to become the crew of SC interplanetary themselves will be exposed to the adverse conditions of outer space.

But this objection can be answered. First: damage will be subject to the robot, and not a living biological being (person), which cannot be replaced. Secondly: you can provide copies of the necessary robotics devices for replacement. Thirdly: Studies in the field of effective sewn in space of materials and electronic components of robots are now actively being carried out as well as the development of self-learning robots, which means self-refining.

And this is no longer fiction for modern science.

Of course, already now there is a need for robots that replace human in extreme conditions of the external environment - in certain works requiring limit physical exertion from a person.

That is, there are partly "deserted" crews - these are already commemoration of today. Immediately it should be noted: all the said application of AI is suitable for terrestrial work in extreme media, and this is relevant; But the extreme environment itself and the conditions of work also cause the need to account for differences even at the level of concepts of building such systems with AI [11].

8.About future promising programs of space research

From here, as it seems to us, the following areas available to us for developing future prospective programs of space research, where efforts are required primarily by theorists - mathematicians:

1.Synchronization of the crew of the spacecraft (SC) and the flight control center (FCC) on Earth. So: unobtrusive, but continuous monitoring of the work of astronauts and the functioning of equipment during individual studies.

2.Adjustment using the AI real trajectory in relation to a given orbit, ensuring work on autopilot, management such important work, such as docking with space station.

3.Management in self-organization mode multi-contact orbital groups; synchronization of complex movements of groups of satellites. This task will require testing and "training" of robots software, and therefore a separate direction - the development of special simulators, the creation of a single (preferably universal) software package for the development and testing of robots of various purposes. The latter, by the way, is one of the directions of our department's work.

4.Selection of a SC landing site on another planet. This is a complex and multidimensional problem that requires cybernetic support.

5.Monitoring the level of radiation outside the KA and in its room, as well as tracking minimum changes in the crew member state (including psychological).

6. One of the directions of application of robots in distant space missions is a robot comrade, the counselor, friend and in some kind of psychotherapist. It may be a robot that

can be realized by one of several "personalities" with the possibility of their restructuring, depending on who from the crew members occurs.

The question of an "artificial personality" was discussed quite in detail at the August 2020 conference under the leadership of the corresponding member of the National Academy of Sciences of Ukraine Anatoly Shevchenko.

Elements of artificial intelligence (decision making operational, without direct human participation) for space research tasks are laid down during programming, in particular, such functions:

1.Anthropomorphic Rescuer Robot in Cosmic Missions:

- tracking of the moods of a particular crew member (according to the characteristics of the voice, behavior - slowness or fuss);
- removal and analysis of life characteristics - blood pressure, body temperature and different parts ...), that is, tracking the state of health;
- operational issuance by voice ordering information;
- analysis of the nature of calls to the robot for receiving references, their quantities and content. This can characterize, albeit indirectly, the psychological state of the cosmonaut;
- depending on the results of analysis of behavior, thus, the robot may give unobtrusive tips, tips, their greetings, up to express suitable aphorisms or jokes. That is, behave as it happens with human communication.

As long as it should be attributed to the near future, but it is obvious that the psychological climate is extremely important in a long-term space flight. [11, 12].

It is clear that at the same time a certain discharge is always required for crew members, which in the specifics of the space mission are in significant voltage and with a feeling of the impossibility of changing their surroundings.

The study of the psychological climate in conditions of long-term isolation in a limited space is relevant and well funded (an example is the international project "SIRIUS-20/21", - 240-day insulating experiment) [10, 11, 12].

2.In addition to the use of robotic systems with AI for the purposes of providing space missions, the "astronomical" direction of use of AI is developing, namely:

- prediction of solar flares, protection against asteroids [14];
- assistance to astronomers in the study of space.

These works are associated with the creation and development of optimal algorithms for processing large data arrays, and in require active work of theoretical mathematicians.

Summary

Based on all these topical tasks, it can be concluded that the following technologies and systems should be developed to implement them:

- neural networks and other technologies that ensure efficient processing of large arrays of heterogeneous satellite and other information, individual images and signals, including those obtained on board;
- expert and other intellectual real-time intelligent systems to ensure the desired level of autonomy of the functioning of robots with a different appointment, including space and underwater research missions, rescue work in various environments;
- technology of self-organization and management of groups of moving facilities (UAV, multi-contact orbital groups, agricultural equipment in the fields,);
- development of intelligent systems to ensure effective support for designing and testing systems with AI, (including space systems and their components).

References

1. Pisarenko V, Pisarenko Yu., Prokopchuk V. // About the method of optimal selection of removing removal. .//Computer mathematics. - 2017. - No. 2. - p.30-36.
2. Pisarenko V., Korneyev S, Kuzko A.V. On the use of underwater robots for expeditionary tasks for monitoring glaciers of the continental shelf of Eastern Antarctica. Artificial Intelligence. - 2017. - No. 2. - p. 150-160.
3. Pisarenko V, Korneyev S, Pisarenko Yu., Varava I. Recognition of fuzzy underwater images // Computer mathematics. - 2018. - No. 1. - p. 90-96.

4. Koval A. Concept of the program for tasks modeling the structure and behavior of mobile robots from AI designed to support search and rescue operations in combination of environments (air, terrestrial, underwater), abstracts of the International Scientific and Practical Conference" Information Technologies and Computer Modeling" (m. Ivano-Frankivsk, May 18-23, 2020).
1. Intelligent technologies of artificial intelligence for mine safety (monograph) // Pisarenko V., Yu. Pisarenko, F.N.
2. Pisarenko V., Gorin, A.S. Kryachko, I. Varava, A. Koval // Kiev: NTUU "KPI" of the publishing and printing center "Polytechnic". - 2013. - 116 p.Varava I., Pisarenko Yu., Fesenko A. About computer methods of diagnostics, maintenance and support of re-treatment of dependent (addictive) patients // Abstracts of the International Scientific and Practical Conference "Information Technologies and Computer Modeling" (Ivano-Frankivsk, May 18-23, 2020), p . 20-22.
3. Pisarenko V.G. Simulation of the problem of interaction of neurons taking into account the lagging of their interaction .// Cybernetics and Systems Analysis.- Vol. 54, No. 3 (2018). - Published by Springer Science+Business Media, LLC. – P.513-516.
4. Pisarenko V.G. Modeling the interaction of a living neural network neurons for artificial intelligence technologies / Pisarenko V.G. // The Ministry of Science and Technology Journal «Adaptive Automatic Control Systems». – 2019. – № 2(35). – С. 64–69.DOI:https://doi.org/10. 20535/1560-8956.35.2019.197433
5. Pisarenko V.G., Pisarenko J.V., Koval O.S., Varava I.A. Concepts of construction and technological solutions for methods of operative transfer of data of field researches from agricultural sites to the remote database of storage of data with a possibility of feedback. Artificial Intelligence, 2019, No. 3-4
6. Pisarenko V., Pisarenko Yu., Gulchak O. // Prospects for using artificial intelligence methods in spacecraft tasks // Artificial Intelligence, No. 4, 2019
7. Project "Sirius-19" UPL http://sirius.imbp.info/
8. NASA SP-2009-3405 HUMAN HEALTH AND PERFORMANCE RISKS OF SPACE EXPLORATION MISSIONS. Evidence Reviewed By the Nasa Human Research Program. https://humanresearchroadmap.nasa.gov/evidence/REPorts/evidensebook.pdf
9. Koval O. The intermediate stage is similar to human artificial intelligence. "Artificial Intelligence", 2020; 25; C7-12, Doi: https://doi.org/10.15407/jai, 2020.01.007
10. Artificial intelligence found new exaplanets https://naked-science.ru/article/sci/iskusstvennyy-intellekt-nashel-novye.

Received 01.04.21
Accepted 10.06.21